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EXAMINER	
NGUYEN, KIMBINH T	
ART UNIT	PAPER NUMBER
2671	

DATE MAILED: 08/02/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)
	09/892,924	SLOAN ET AL.
	Examiner	**Art Unit**
	Kimbinh T. Nguyen	2671

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *26 June 2001*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-41* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☒ Claim(s) *29 and 30* is/are allowed.

6)☒ Claim(s) *1-25,28 and 31-41* is/are rejected.

7)☒ Claim(s) *26 and 27* is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date *8/21/03*.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

1. Claims 1-41 are pending in the application.

Claim Rejections - 35 USC § 103

2. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

3. Claims 1, 2, 4, 7, 20, 22, 24, 31, 34-37 are rejected under 35 U.S.C. 103(a) as being unpatentable over Cabral et al. (5,949,424).

Claim 1, Cabral et al. teaches rendering a graphical object (multiple rendering passes; col. 15, lines 50-67), the method comprising: defining a bump map to describe a bump mapped surface on a three-dimensional graphical object (a tangent space transform is defined and used to accelerate bump mapping shading; col. 2, lines 53-60; figs. 1, 2A); and determining a horizon map for the bump mapped surface (a perturbed normal texture map) in a plurality of color channels of a set of texture maps. Cabral et al. does not describe a horizontal map for the bump map surface; however, Cabral et al. teaches a perturbed normal texture map (col. 3, lines 34), this feature related to a horizontal map, because the perturbed normal texture map has texels defined by three perturbed normal components, representing or approximating in tangent space (which including a lighting vector (color channels), a viewing vector, a half angle vector, and a reflection vector(diffuse and specular components can be used in any lighting equation

to determine a color value for a respective pixel)) the differential surface of the object surface when perturbed by a height field f(u,v). The perturbed map can be surface dependent or surface independent. Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to utilize the horizontal map (a perturbed normal texture map) taught by Cabral for accelerating shading of an object surface by bump mapping in tangent space, because shading vectors used in a bump mapping shading model are transformed to tangent space. For greatest shading quality, the shading vectors are transformed on a per-pixel basis. To reduce computation cost (col. 6, lines 35-45).

Claim 2, Cabral et al. teaches defining light having a direction relative to the bump mapped surface (a lighting vector L; col. 10, lines 56-59); interpolating from the horizon map relative to the direction of light to determine those portions of the bump mapped surface that are (col. 4, lines 1-41): lit by the defined light; and in a shadow cast by a bump of the bump mapped surface; rendering, from a given point of view, the lit portions of the bump mapped surface (vertices are transformed and lit, and primitives are clipped to a viewport; col. 12, lines 60-63; col. 16, lines 1-3).

Claim 4, Cabral et al. teaches rendering, from a given point of view, the lit portions of the bump mapped surface comprises: applying bump map data from the bump map to a perspective view of the three-dimensional graphical object; merging the set of texture maps with the bump map data; and displaying, from the given point of view, the perspective view of the three-dimensional graphical object on a computer display (col. 15, line 50 through col. 17, line 2).

Claim 7, the rationale provided in the rejection of claim 2 is incorporated herein. In addition, teaches computer-executable instructions.

Claim 20, the rationale provided in the rejection of claim 2 is incorporated herein.

Claim 22, Cabral et al. teaches determining at least two of the radial directions in the tangent plane around the corresponding vertex of each polygon to the direction of the light source (lighting and viewing vectors L, V; col. 6, lines 35-59); and interpolating from the angle in the color channel in the text map corresponding to the at least two radial directions (figs. 9A and 9B).

Claim 24, Cabral et al. teaches defining a horizon map of the surface including, for each of a plurality of radial directions in the tangent plane around each vertex, the largest angle between the normal vector and any direct ray of light to the vertex (col. 11, lines 20-63); and storing the horizon map as a set of texture maps corresponding to the surface on the three-dimensional graphical object (col. 19, line 59 through col. 20, line 26).

Claim 31, Cabral et al. teaches a memory to store: a frame buffer including a plurality of pixels in a representation of a three-dimensional graphical object (frame buffer 2070 of fig. 2B); a bump map of a bump mapped surface on the three-dimensional graphical object and texture maps (figs. 3 and 4), corresponding to horizon maps of the bump mapped surface, for reuse in rendering the three-dimensional graphical object; a display device (display 2080 of fig. 2B); a processor (processor 804 of fig. 8), coupled to the display device and the memory, to process each pixel to produce on the display device a rendering of the bump mapped surface with shadows

cast, as a function of horizon maps, by light impinging upon bumps on the bump mapped surface (multiple rendering passes routine for bump mapping in tangent space; fig. 7A).

Claim 34, Cabral et al. teaches a database having a first set of data representing a bump map for the bump mapped surface and second set of data corresponding to horizon map of the bump mapped surface(a main memory 808; fig. 8), wherein the second set of data is stored in color channels of a texture map for reuse in rendering a three-dimensional graphical object (secondary memory; fig. 8); a processor operatively connected to receive the first and second sets of data and including a logic element implemented as hardware that (processor 808; fig. 8): interpolates light in a direction with respect to the horizon map (figs. 9A and 9B); and determines from the interpolated light direction pixels that are representative of a rendering of the bump mapped surface on the three-dimensional graphical object that are shadowed by light cast upon bumps on the bump mapped surface; an input device (hard disk drive; fig. 8), coupled to the processor, for interactively inputting instructions to the processor that change the direction of light relative to the bump mapped surface (fig. 8).

Claim 35, Cabral et al. teaches the processor generates a display signal (display interface 805; fig. 8): incorporating for display those pixels that are lit by light in the direction with respect to the horizon map; and does not incorporating for display those pixels that are in shadowed by light cast upon the bumps on the bump mapped surface (col. 16, lines 1-67).

Claim 36, Cabral et al. teaches bump map of a bump mapped surface on a three-dimensional graphical object (fig. 1), a plurality of texture maps including a plurality of horizon maps of the bump mapped surface (perturbed normal vector map; col. 3, lines 24-67).

Claim 37, the rationale provided in the rejections of claims 31, 33 and 34 are incorporated herein.

4. Claims 3, 5, 6, 8-12, 14-19, 21, 25, 33, 38-41 are rejected under 35 U.S.C. 103(a) as being unpatentable over Cabral et al. (5,949,424) in view of Collodi (6,624,812).

Claim 3, Cabral does not teach changing the direction of light; however, Collodi teaches interactively receiving instructions that change the direction of light relative to the bump mapped surface (the 3D light vector is rotated to correspond with the polygon direction vector (col. 2, lines 33-45; fig. 3); repeating the interpolating using the changed direction of light; and repeating the rendering using the changed direction of light to render lit portions of the bump mapped surface (fig. 6). It would have been obvious to one of ordinary skill in the art at the time the invention was made to incorporate the rotated 3D light vector taught by Collodi into the method and system for accelerated shading of an object surface by bump mapping in tangent space for changing the direction of light, because it would implement within a computer hardware for fast and efficient determination of pixel lighting coefficients (col. 3, lines 45-47).

Claim 5, Cabral et al. does not teach radial direction in a tangent plane; however, Collodi teaches each texture map includes, for one encoded radial direction in a tangent plane around each vertex of a plurality of primitives defining the surface of the three-

dimensional graphical object (figs. 7 and 8), the smallest angle between a normal vector to the vertex and a vector from the vertex to one of the bumps on the bump mapped surface in the one radial direction (a bump map angle vector is never required to be greater that 90 degrees from surface normal; col. 7, lines 26 through col. 9, line 67). It would have been obvious to one of ordinary skill in the art at the time the invention was made to incorporate the radial direction, a bump map angle vector taught by Collodi into the method and system for accelerated shading of an object surface by bump mapping in tangent space for changing the direction of light, because the use of angle proportional 2D surface angle vectors in conduction with an environment map, it would allow for greater environment map coverage as well as the accurate and consistent inclusion of bump mapping (col. 11, lines 17-22). **Claim 6**, Collodi also teaches the set of texture maps comprises two texture maps each corresponding to not more than four radial directions in a tangent plane around each vertex of primitives defining the surface of the three-dimensional graphical object (n, b and c vectors; figs. 7 and 8); and each the radial direction is relative to a tangent plane of a surface on the three-dimensional graphical object; and each the radial direction is encoded in one color channel of one the color channel (the exact color value of the current pixel can then be calculated by blending algorithms (col. 10, lines 23-57).

Claim 8, the rationale provided in the rejections of claims 1 and 3 are incorporated herein.

Claims 9 and 10, the rationale provided in the rejections of claims 2 and 3 are incorporated herein.

Claim 11, Cabral et al. does not teach radial direction in a tangent plane; however, Collodi teaches each derivation of each of the horizon maps includes at least one of the radial directions that is:

from about zero radians to about $\Pi/2$ radians (0-90 degrees; a bump map angle vector is never required to be greater than 90 degrees from surface normal; col. 7, line 67 through col. 8, line 1);

from about $\Pi/2$ radians to about Π radians (90-180 degrees);

from about Π radians to about $3\Pi/2$ radians (180-270 degrees); and

from about $3\Pi/2$ radians to about 2Π radians (270-360 degrees). It would have been obvious to one of ordinary skill in the art at the time the invention was made to incorporate the radial direction, a bump map angle vector taught by Collodi into the method and system for accelerated shading of an object surface by bump mapping in tangent space for changing the direction of light, because the use of angle proportional 2D surface angle vectors in conduction with an environment map, it would allow for greater environment map coverage as well as the accurate and consistent inclusion of bump mapping (col. 11, lines 17-22). **Claim 12**, Collodi also teaches the interpolating further comprises determining at least two of the radial directions to the direction of light relative to the tangent plane (figs. 7 and 8).

Claim 14, the rationale provided in the rejection of claim 9 is incorporated herein. In addition, Cabral et al teaches the horizon map for each of the vertices is stored in a texture map having color channels (col. 19, line 58 through col. 20, line 26); and the

corresponding horizon angle of the horizon map for each of the radial direction around each of the vertex is in a color channel of the corresponding texture map (figs. 3 and 4).

Claims 15-18, the rationale provided in the rejections of claims 11-13 are incorporated herein.

Claim 19, Cabral et al. teaches representing a surface on a three-dimensional graphical object by polygons, each polygon having vertices, each vertex defining a point in a tangent plane of the surface (surface point P in fig. 1); perturbing a vertex normal vector of the surface at each vertex to define bumps on the surface (col. 3, lines 13-23); and defining in a color channel of a texture map (col. 11, line 20 through col. 12, line 24), for each of a plurality of radial directions in the tangent plane around each vertex, the smallest angle between the vertex normal vector and a vector from the vertex to one of the bumps in the respective radial direction. Cabral et al. does not teach radial direction in a tangent plane; however, Collodi teaches the smallest angle between the vertex normal vector and a vector from the vertex to one of the bumps in the respective radial direction (a bump map angle vector is never required to be greater that 90 degrees from surface normal; col. 7, lines 26 through col. 9, line 67). It would have been obvious to one of ordinary skill in the art at the time the invention was made to incorporate the radial direction, a bump map angle vector taught by Collodi into the method and system for accelerated shading of an object surface by bump mapping in tangent space for changing the direction of light, because the use of angle proportional 2D surface angle vectors in conduction with an environment map, it would allow for

greater environment map coverage as well as the accurate and consistent inclusion of bump mapping (col. 11, lines 17-22).

Claim 21, the rationale provided in the rejections of claim 10 is incorporated herein.

Claim 25, the rationale provided in the rejections of claims 2, 3 and 24 is incorporated herein.

Claim 33, Cabral et al. teaches an input device (hard disk drive), coupled to the processing unit, to communication an interactive instruction to the processor (fig. 8) that changes the direction of light relative to the bump mapped surface. Cabral does not teach changing the direction of light; however, Collodi teaches interactively receiving instructions that change the direction of light relative to the bump mapped surface (the 3D light vector is rotated to correspond with the polygon direction vector (col. 2, lines 33-45; fig. 3). It would have been obvious to one of ordinary skill in the art at the time the invention was made to incorporate the rotated 3D light vector taught by Collodi into the method and system of Cabral for accelerated shading of an object surface by bump mapping in tangent space for changing the direction of light, because it would implement within a computer hardware for fast and efficient determination of pixel lighting coefficients (col. 3, lines 45-47).

Claim 38, the rationale provided in the rejection of claim 3 is incorporated herein.

Claims 39-41, the rationale provided in the rejections of claims 7, 32 and 33 are incorporated herein.

5. Claims 13, 23 and 28 are rejected under 35 U.S.C. 103(a) as being unpatentable over Cabral et al. (5,949,424) in view of Collodi (6,624,812) and further in view of Peercy et al. (5,880,736).

Claim 13, the rationale provided in the rejection of claim 9 is incorporated herein. In addition, Cabral et al. does not teach radial direction in a tangent plane; however; Peercy et al. teaches a computer-readable media comprising computer-executable instructions (col. 29, lines 26-30). It would have been obvious to one of ordinary skill in the art at the time the invention was made to incorporate a computer-readable media taught by Peercy into the method and system for accelerated shading of an object surface by bump mapping in tangent space for changing the direction of light, because it would enable a graphic processor in a computer system to shade an object surface in a computer graphic image (col. 29, lines 28-30).

Claim 23, the rationale provided in the rejections of claim 20 is incorporated herein. In addition, Cabral et al. does not teach computer-readable media; however; Peercy et al. teaches a computer-readable media comprising computer-executable instructions (col. 29, lines 26-30). It would have been obvious to one of ordinary skill in the art at the time the invention was made to incorporate a computer-readable media taught by Peercy into the method and system for accelerated shading of an object surface by bump mapping in tangent space for changing the direction of light, because it would enable a graphic processor in a computer system to shade an object surface in a computer graphic image (col. 29, lines 28-30).

Claim 28, the rationale provided in the rejection of claim 25 is incorporated herein. In addition, Cabral et al. does not teach computer-readable media; however; Peercy et al. teaches a computer-readable media comprising computer-executable instructions (col. 29, lines 26-30). It would have been obvious to one of ordinary skill in the art at the time the invention was made to incorporate a computer-readable media taught by Peercy into the method and system for accelerated shading of an object surface by bump mapping in tangent space for changing the direction of light, because it would enable a graphic processor in a computer system to shade an object surface in a computer graphic image (col. 29, lines 28-30).

6. Claim 32 is rejected under 35 U.S.C. 103(a) as being unpatentable over Cabral et al. (5,949,424) in view of Ho et al. (6,297,833).

Claim 32, Cabral et al. does not teach alpha color channel; however, Ho et al. teaches each texture map has red, green, blue, and alpha color channels (col. 2, lines 57-43; col. 7, line 60 through col. 8, line 14); and each color channel has encoded therein a representation of at least one radial direction of the corresponding horizon map for one point on the bump mapped surface (col. 8, line 61 through col. 9, line 2). It would have been obvious to one of ordinary skill in the art at the time the invention was made to incorporate color and alpha channels taught by Ho into the method and system of Cabral for accelerated shading of an object surface by bump mapping in tangent space for changing the direction of light, because an alpha value is carried as a component of the texture values which is used to determine the amounts of each of the r, g and b color values defining that particular pixel (col. 3, lines 38-43).

Allowable Subject Matter

7. Claims 26 and 27 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

The following is a statement of reasons for the indication of allowable subject matter:

The prior art does not teach each vertex, each texture map has a plurality of colors channels, each color channel having encoded therein the largest angle between the normal vector and any direct ray of light to the vertex that does not contact any of the bumps on the surface; the set of texture maps comprises two texture maps; and each texture map: corresponding to not more that four of the radial directions; and has four colors channels each having not more than one radial direction encoding for the corresponding largest angle for each vertex between the normal vector and any direct ray of light to the vertex that does not contact any of the bumps on the surface.

8. Claims 29 and 30 are allowed.

The following is a statement of reasons for the indication of allowable subject matter: The prior art does not teach the perturbed normal vector value at the vertex to obtain cosine; setting a color mask upon the frame buffer, wherein the color mask will not write to the color channels of the texture maps, whereby the ambient low level lighting term previously rendered is preserved

9. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Kimbinh T. Nguyen whose telephone number is (703) 305-9683. The examiner can normally be reached on Monday to Thursday from 7:00 AM to 4:30 PM. The examiner can also be reached on alternate Friday from 7:00 AM to 3:30 PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Mark Zimmerman, can be reached at (703) 305-9798. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

July 26, 2004

Kimbinh Nguyen

Kimbinh Nguyen

Patent Examiner AU 2671